

**Listing of Claims:**

1. (canceled)

2. (canceled)

3. (presently amended) A robust adaptive filter comprising:

an adaptive filter utilizing a fast converging adaptive algorithm;

means for modifying said algorithm by the application thereto of an  
adaptive scaled non-linearity; and

a double talk detector connected to said adaptive filter for disabling said  
adaptive filter in response to the detection of double talk on a telephone circuit, said double talk  
detector also connected to said modifying means for controlling adaptation of said adaptive  
scaled non-linearity so as to reduce the impact of double talk on said filter by reducing  
divergence in a period of undetected double talk;

wherein the fast converging algorithm is PNLMS.

4. (previously presented) A robust adaptive filter comprising:

an adaptive filter utilizing a fast converging adaptive algorithm;

means for modifying said algorithm by the application thereto of an  
adaptive scaled non-linearity; and

a double talk detector connected to said adaptive filter for disabling said  
adaptive filter in response to the detection of double talk on a telephone circuit

wherein the fast converging algorithm is PNLMS++.

5. (presently amended) A robust adaptive filter comprising:

an adaptive filter utilizing a fast converging adaptive algorithm;

means for modifying said algorithm by the application thereto of an adaptive scaled non-linearity; and

a double talk detector connected to said adaptive filter for disabling said adaptive filter in response to the detection of double talk on a telephone circuit, said double talk detector also connected to said modifying means for controlling adaptation of said adaptive scaled non-linearity so as to reduce the impact of double talk on said filter by reducing divergence in a period of undetected double talk;

wherein the fast converging algorithm is APA.

6. (previously presented) A robust adaptive filter comprising:

an adaptive filter utilizing a fast converging adaptive algorithm;

means for modifying said algorithm by the application thereto of an adaptive scaled non-linearity; and

a double talk detector connected to said adaptive filter for disabling said adaptive filter in response to the detection of double talk on a telephone circuit;

wherein the fast converging algorithm is PAPA.

7. (previously presented) The filter of claim 3, wherein the adaptive scaled non-linearity is given by the formula:

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign} \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean}$$

error divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

8. (previously presented) The filter of claim 4, wherein the adaptive scaled non-linearity is given by the formula:

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign} \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean}$$

error divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

9. (previously presented) The filter of claim 5, wherein the adaptive scaled non-linearity is given by the formula:

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign} \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean}$$

error divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

10. (previously presented) The filter of claim 6, wherein the adaptive scaled non-linearity is given by the formula:

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign} \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean}$$

error divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

11. (canceled)

12. (canceled)

13. (previously presented) A robust echo canceller comprising:

an adaptive filter for outputting an error signal in response to a detected echo signal; and

means for supplying adaptive filter coefficients to said filter, wherein said

filter coefficients are given by the formula:  $h_{n+1} = h_n + \frac{\mu}{x_n^T G_n x_n + \delta} G_n x_n \varphi(|e_n|) \text{sign}\{e_n\}$ , wherein  $h_n$

is the estimated echo path;  $\mu$  is the overall step size parameter;  $G_n$  is the excitation matrix;  $x_n$  is the excitation vector;  $\delta$  is the regularization parameter that prevents division by zero;  $|e_n|$  is the mean error; and  $\{e_n\}$  is a sample of echo signal.

14. (previously presented) The echo canceller of claim 13, further comprising

a double talk detector connected to a telephone circuit for disabling said means for supplying adaptive filter coefficients in response to the detection of double talk on said circuit.

15. (previously presented) A robust echo canceller comprising:

an adaptive filter for outputting an error signal in response to a detected echo signal; and

means for supplying adaptive filter coefficients to said filter, wherein said filter

coefficients are given by the formula:  $h_{n+1} = h_n + \mu G_n X_n R_{xx}^{-1}(n) [\varphi(|e_n|) \odot \text{sign}(\{e\}_{\underline{e}_n})]$ , wherein  $h_n$

is the estimated echo path;  $\mu$  is the overall step size parameter;  $G_n$  is the step-size matrix;  $X_n$  is

the excitation matrix;  $R_{xx}^{-1}$  is the correlation matrix;  $|e_n|$  is the mean error;  $\odot$  denotes elementwise multiplications; and  ~~$\{e_n\}$  is a sample of echo signal~~  $e_n$  is a residual echo vector.

16. (previously presented) The echo canceller of claim 15, further comprising a double talk detector connected to a telephone circuit for disabling said means for supplying adaptive filter coefficients in response to the detection of double talk on said circuit.

17 (new) A robust adaptive filter comprising:  
an adaptive filter utilizing a fast converging adaptive algorithm;  
means for modifying said algorithm by the application thereto of an adaptive scaled non-linearity; and

a double talk detector connected to said adaptive filter for disabling said adaptive filter in response to the detection of double talk on a telephone circuit, said double talk detector also connected to said modifying means for controlling adaptation of said adaptive scaled non-linearity so as to reduce the impact of double talk on said filter by reducing divergence in a period of undetected double talk;

wherein the fast converging algorithm is PNLMS++.

18. (new) The filter of claim 17, wherein the adaptive scaled non-linearity is given by the formula:

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign } \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean}$$

error divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

19. (new) A robust adaptive filter comprising:

an adaptive filter utilizing a fast converging adaptive algorithm;

means for modifying said algorithm by the application thereto of an

adaptive scaled non-linearity; and

a double talk detector connected to said adaptive filter for disabling said adaptive filter in response to the detection of double talk on a telephone circuit, said double talk detector also connected to said modifying means for controlling adaptation of said adaptive scaled non-linearity so as to reduce the impact of double talk on said filter by reducing divergence in a period of undetected double talk;

wherein the fast converging algorithm is PAPA.

20. (new) The filter of claim 19, wherein the adaptive scaled non-linearity is given by the formula:

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign } \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean}$$

error divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.